



OPTIMIZING EARLY DETECTION: KEY FACTORS INFLUENCING HOSPITAL EARLY WARNING SYSTEM IMPLEMENTATION – A SYSTEMATIC REVIEW

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ABSTRACT

Early Warning System (EWS) is a clinical tool used to detect early signs of patient deterioration and prevent delayed interventions. Despite broad implementation, challenges persist related to healthcare providers' readiness, organizational support, system design, and varied care environments. This study aims to identify and analyze factors influencing EWS implementation based on recent empirical evidence to support more effective and sustainable use in healthcare settings. A systematic review was conducted using five electronic databases: PubMed, Scopus, ScienceDirect, SpringerLink and ProQuest. The search employed key terms including "Early Warning System," "EWS score," "National Early Warning Score," "NEWS2," "hospital," "implementation," "adherence," "barriers," "facilitators," and "healthcare professionals." A total of 1,163 articles were initially identified. Following duplicate removal, title and abstract screening, and full-text assessment in accordance with PRISMA guidelines, 23 peer-reviewed articles met the inclusion criteria. Eligible studies were open-access, published in English between 2018 and 2025, and reported original empirical findings related to EWS implementation. This review was registered with PROSPERO. The included studies identified four major categories of factors influencing EWS implementation: (1) Individual factors, including clinical experience, attitudes, knowledge, and emotional readiness; (2) Organizational factors, such as managerial support, patient safety culture, infrastructure, and institutional policies; (3) Intervention-related factors, including system design, training quality, and integration with information technology; and (4) Environmental factors, encompassing resource availability, facility conditions, and the need for local adaptation. Successful implementation of Early Warning Systems requires a comprehensive and integrated approach. Effectiveness and long-term sustainability are influenced by the extent to which implementation strategies are aligned with local clinical contexts, supported by structured training programs, embedded within a strong patient safety culture, and reinforced through multidisciplinary collaboration.

Keywords: early warning system; EWS implementation; nurse; patient safety

How to cite (in APA style)

Faiz, H. F. N., & Basabih, M. (2026). Optimizing Early Detection: Key Factors Influencing Hospital Early Warning System Implementation – A Systematic Review. *Indonesian Journal of Global Health Research*, 8(3), 1003–1014. <https://doi.org/10.37287/ijghr.v8i3.1147>.

INTRODUCTION

Patient safety stands as a central pillar of effective healthcare systems, focusing on minimizing preventable harm and addressing risks that arise during patient care. The statistics are sobering (Azyabi et al., 2021; World Health Organization, 2023). According to the World Health Organization, approximately one in every ten patients suffers an adverse event during hospitalization, with unsafe care resulting in up to 2.6 million deaths annually, a burden that disproportionately affects low- and middle-income countries (World Health Organization, 2019). In the United States, medical errors have been identified as the third leading cause of death, following heart disease and cancer, accounting for over 250,000 deaths each year (Makary & Daniel, 2016). The situation in Europe is similarly concerning, with between 8% and 12% of hospitalized patients experiencing adverse events that could have been prevented (de Vries et al., 2008). These figures collectively highlight the urgent need to prioritize patient safety as a fundamental indicator of healthcare quality (Ulumiyah, 2018).

High-quality healthcare goes well beyond sophisticated technology or state-of-the-art facilities; at its core, it depends on meaningful collaboration between healthcare professionals and patients

(Mosadeghrad, 2014). Timely, appropriate responses from clinical staff when a patient's condition starts to decline are crucial especially in acute care settings (Zeng et al., 2024). If physiological deterioration is identified early usually through abnormal vital signs and intervention occurs promptly, adverse outcomes can often be averted (Bingham et al., 2015).

Hospitals frequently rely on the Code Blue system to manage critical events like cardiac or respiratory arrest (Nelson et al., 2024). The entire system hinges on staff being able to rapidly and accurately identify at-risk patients, then respond with effective medical intervention (Zeng et al., 2024). Several factors shape the success of Code Blue events, including rapid team response, availability of resuscitation equipment, staff training and experience, and clear, efficient communication (Carter, Saron, Blake, et al., 2022).

To strengthen early recognition of patient decline, many hospitals have adopted the Early Warning System (EWS). This clinical tool uses routinely collected vital signs to flag patients who may be deteriorating, triggering increased surveillance or activating a rapid response team when certain thresholds are crossed (García-del-Valle et al., 2021; Gerry et al., 2020). Research shows that EWS improves patient monitoring, decreases Code Blue events, and improves survival rates (Ehara et al., 2024; Sutton et al., 2014).

Mathukia et al demonstrated a reduction in Code Blue events in non-ICU units from 0.05 to 0.02 per 100 patient-days after implementing EWS (Mathukia et al., 2015). Similarly, Giwangkancana et al.'s six-year study in Indonesia, analyzing over 2,000 Code Blue calls, found that higher EWS scores were strongly associated with increased risk, highlighting the system's usefulness for early detection (Giwangkancana et al., 2025).

Although EWS has demonstrated clear benefits, significant challenges in implementation remain. Failure to identify and respond to patient deterioration remains a stubborn problem in many hospitals (Eddahchouri et al., 2021). While EWS can be highly effective if properly implemented, success depends on critical thinking, accurate interpretation of scores, and strict adherence to escalation protocols skills that frontline nurses, in particular, must master (Astuti et al., 2023; García-del-Valle et al., 2021; Prihati & Wirawati, 2019).

Yet, inconsistencies in EWS use are well documented. Barriers include insufficient staff training (especially among new staff), lack of ongoing support, and limited infrastructure (Rosakawati, 2019). One hospital in Malang reported that 75% of nurses struggled with EWS; half made documentation or interpretation errors (QY et al., 2020). Furthermore, Rorimpandey reported that only 81% of inpatient documentation related to EWS protocols was complete, indicating lapses in standard implementation. Clearly, factors such as communication, resource availability, staff engagement, and organizational structure can all influence EWS effectiveness (Rorimpandey, 2019).

There is strong evidence that EWS improves patient safety, but in practice, implementation often falls short of the ideal. Protocols are not always followed, and systemic issues persist (Prihati & Wirawati, 2019). O'Neill and colleagues identified multiple factors affecting clinical escalation, including governance, professional boundaries, rapid response team function, clinical experience, and system design. Their focus, however, was mainly on why escalation fails, rather than on broader EWS implementation issues (O'Neill et al., 2021). In light of these challenges, this systematic review aims to identify critical factors influencing effective EWS implementation in hospital wards and to provide evidence-based recommendations to enhance compliance and improve early intervention for clinical deterioration.

METHOD

This study employed a systematic review design to explore factors influencing the implementation of Early Warning Systems (EWS) in hospital settings. The review focused on literature published between 2018 and 2025, following the release of the *National Early Warning Score (NEWS) 2: Standardising the Assessment of Acute-Illness Severity in the NHS* guidelines by the Royal College of Physicians in 2017 (Royal College of Physicians, 2017). The population of interest consisted of published research articles involving healthcare professionals, particularly nurses and physicians, who were engaged in EWS implementation and clinical assessments related to patient deterioration. The literature search was conducted over a two-week period, from 1 to 16 April 2025, using five major academic databases: PubMed, Scopus, ScienceDirect, SpringerLink, and ProQuest. Guided by the PICO framework, the search strategy employed a combination of keywords and Boolean operators, including “Early Warning System,” “EWS score,” “National Early Warning Score,” “NEWS2,” “hospital,” “healthcare setting,” “implementation,” “adherence,” “compliance,” “barriers,” “facilitators,” “nurses,” “physicians,” “healthcare professionals,” “patient deterioration,” “clinical deterioration,” “critical illness,” and “Code Blue.” The initial search was intentionally broad, with no restrictions on publication year, language, or study design to ensure comprehensive coverage of relevant evidence. Subsequent screening and eligibility assessment refined the selection to identify the most relevant and methodologically robust studies. The article selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews) guidelines (Moher et al., 2009), and the review was registered in PROSPERO. Table 1 presents the preliminary search results obtained from each database prior to duplicate removal and further rigorous screening.

Table 1. Online Database Search Results

Database	Keywords	Number
PubMed	("Early Warning System" OR "EWS score" OR "National Early Warning Score" OR "NEWS2") AND ("hospital" OR "healthcare setting" OR "clinical practice") AND ("implementation" OR "adherence" OR "compliance" OR "barriers") AND ("nurses" OR "physicians" OR "health personnel") AND ("patient deterioration" OR "clinical deterioration" OR "critical illness" OR "Code Blue")	496
Scopus	TITLE-ABS-KEY(("Early Warning System" OR "EWS score" OR "National Early Warning Score") AND ("hospital" OR "healthcare setting" OR "clinical practice") AND ("implementation" OR "adherence" OR "compliance" OR "barriers") AND ("nurses" OR "physicians" OR "health personnel") AND ("patient deterioration" OR "clinical deterioration" OR "critical illness" OR "Code Blue"))	50
ScienceDirect	("Early Warning System" OR "EWS") AND ("hospital" OR "healthcare setting") AND "implementation" AND ("nurses" OR "physician") AND ("patient deterioration" OR "Code Blue")	341
SpringerLink	("Early Warning System" OR "EWS" OR "National Early Warning Score" OR "NEWS2") AND (implementation OR adherence OR compliance OR barriers OR facilitators OR effectiveness) AND (nurses OR doctors OR "healthcare professionals" OR "clinical staff") AND ("patient deterioration" OR "clinical deterioration" OR "Code Blue" OR "critical illness" OR "patient safety") AND ("hospital setting" OR "acute care" OR "healthcare facility")	251
ProQuest	ALL("Early Warning System" OR "EWS score") AND ALL("hospital" OR "healthcare facility") AND ALL("implementation" OR "barriers" OR "adoption") AND ALL("nurses" OR "physicians" OR "healthcare professionals") AND ALL("effectiveness" OR "compliance" OR "patient safety")	25

The sample for this review comprised peer-reviewed, full-text journal articles published in English. Eligible studies specifically presented original empirical findings concerning the implementation of EWS within hospital settings, without restriction to any particular clinical department or geographical location. Studies such as reviews, editorials, commentaries, protocols, or those lacking primary data or peer review were excluded to maintain the rigor of the analysis.

Data extraction and narrative synthesis were conducted for each included study. Key parameters examined encompassed study design, context, population, principal findings, and the factors

reported as influencing the success or challenges of EWS implementation. The inclusion criteria allowed for a broad spectrum of methodologies qualitative research, mixed-methods, observational studies, and case studies thereby enriching the analysis with diverse perspectives from multiple healthcare systems and clinical environments.

This approach aimed to identify not only the recurring themes and barriers encountered during EWS implementation but also the broader organizational and contextual influences affecting its integration into everyday clinical practice. The resulting synthesis offers a comprehensive evidence base intended to inform future interventions and policy development, ultimately supporting enhanced patient safety and timelier clinical responses to deterioration within hospital settings.

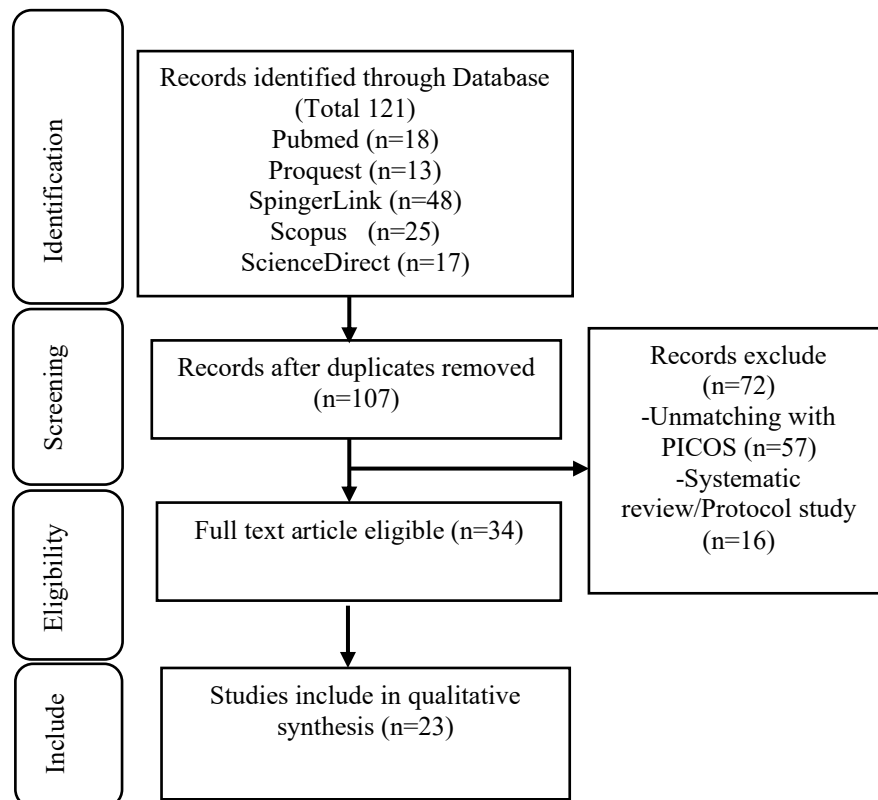


Figure 1. PRISMA Flowchart

RESULT

EWS including NEWS (National Early Warning System), PEWS (Pediatric Early Warning System), and MEOWS (Modified Early Obstetric Warning System) have become standard tools in clinical settings to enhance vigilance and accelerate response to patient deterioration. However, their effectiveness is influenced by complex factors involving individual healthcare workers, organizational readiness, and broader social and policy dynamics (Agulnik, Ferrara, et al., 2022; Dwyer et al., 2024; McKay et al., 2023; Prastya et al., 2023).

This systematic review analyzed 23 eligible articles published between 2018 and 2025, selected from an initial pool of 121 using the PICO framework. These studies examined factors affecting EWS implementation in hospitals, which were categorized into four domains: individual, organizational, intervention-related, and environmental factors. The full list of selected articles is shown in Table 2 below.

Table 2. List of Articles Obtained and Selected Based on PRISMA Inclusion and Exclusion Criteria

Author (Year)	Objective	Method	Key Findings
Agulnik, Ferrara, et al. (2022)	Barriers/facilitators of PEWS in pediatric oncology	Qualitative	Staff resistance, low resources; overcome by local adaptation
Smith et al. (2019)	Behavioral intervention to improve EWS use	Mixed-method	Identified behavioral domains; training essential
Prastya et al. (2023)	EWS documentation in psychiatric hospital	Cross-sectional	Workload & training affect EWS documentation
Swami et al. (2023)	Evaluate EWS in internal medicine ward	Quality Improvement (PDSA)	Stakeholder support and digitization needed
Moore et al. (2019)	Assess MOEWS in Ethiopia	Mixed-method	Improved monitoring; low documentation of action
Brangan et al. (2018)	Staff experience using NEWS outside hospitals	Qualitative	Useful but needs contextual adaptation
Dwyer et al. (2024)	Factors influencing EWS compliance	Survey	Attitudes, norms, documentation barriers
Mikhail & King (2025)	Readiness to detect deterioration	Qualitative	Themes: confidence, support, education
Sujalmo et al. (2022)	EWS effect on decision-making	Mixed-method	Experience/support required; EWS seen as complex
Connor et al. (2025)	Nurses' judgment with EWS	Grounded theory	Nurses balance protocol & judgment via "Acknowledging"
van der Fluit et al. (2021)	Implement B-PEWS in Brazil	Retrospective	Improved scoring; team effort critical
McElroy et al. (2019)	Evaluate PEWS in ER	Mixed-method	Better documentation, communication; workload concerns
Woo et al. (2023)	PEWS sustainability strategies	Qualitative	Training & leadership support essential
Flenady et al. (2020)	Sociocultural factors in EWS	Qualitative	Use influenced by professional & organizational culture
Braun et al. (2022)	Nurses' views on centralized EWS	Focus group	Alerts often disruptive/inaccurate; unclear actions
Graverholt et al. (2024)	NEWS2 in nursing homes	Cluster-RCT	Training increased EWS use significantly
Dryden-Palmer et al. (2022)	Implement BedsidePEWS via PRISM	Multi-case	Adapted framework to local context; effective
Gawronski et al. (2021)	BedsidePEWS compliance	Observational	Low documentation compliance; delayed reviews
Blythe et al. (2024)	Clinician views on predictive models	Qualitative	Models should support—not replace—clinical thinking
Hamada et al. (2025)	Improve RR measurement post-EWS	Quality Improvement with time series	RR measurement improved at each intervention phase
Mills et al. (2021)	PEWS adaptation in Palestine	PDSA cycles	High completeness and accuracy post-EMR
Agulnik, Schmidt-Grimminger, et al. (2022)	PEWS sustainability in Latin America	Qualitative (CCS)	Sustainability linked to leadership, practice integration, and outcomes
Carter, Saron, Siner, et al. (2022)	Perceptions of DETECT e-PEWS	Qualitative	Nurses more compliant; doctors less consistent

DISCUSSION

Drawing from the reviewed studies, several recurring barriers to the implementation of EWS have been identified. These include insufficient training opportunities, limited staff comprehension of the system, resistance to organizational change, and the pressures of heavy workloads (Connor et al., 2025; Sujalmo et al., 2022). Conversely, successful implementation appears to be facilitated by strong managerial commitment, the presence of a robust safety culture, active engagement of multidisciplinary teams, and the provision of adequate resources (Moore et al., 2019; Swami et al., 2023; van der Fluit et al., 2021). The following sections present a synthesis of these findings in relation to the study's research question.

Individual Factors

Clinical experience emerges as a critical factor in the effective use of EWS. Nurses with extensive professional experience often demonstrate heightened clinical awareness and intuition, enabling them to recognize early signs of patient deterioration even before EWS generates an alert (Connor et al., 2025; Mikhail & King, 2025). For these practitioners, clinical judgment serves as a valuable complement to, rather than a substitute for, the system. In contrast, less experienced nurses frequently encounter challenges due to the gap between theoretical knowledge and practical application, which can create uncertainty in identifying subtle signs of decline. Junior staff may also face emotional barriers such as hesitation or fear that hinder timely escalation (Dwyer et al., 2024).

Equally important are healthcare workers' attitudes toward EWS protocols, which strongly influence compliance. These attitudes are shaped by personal beliefs, organizational norms, and perceptions of autonomy in clinical decision-making. Resistance is not uncommon, with some staff perceiving EWS as restrictive, undermining professional judgment, or lacking sensitivity to individual patient contexts concerns more often expressed by physicians than by nurses (Carter, Saron, Siner, et al., 2022; Smith et al., 2019).

Knowledge and training further determine the reliability of EWS use. Nurses who receive adequate training typically demonstrate stronger documentation practices and greater adherence to escalation procedures (Dryden-Palmer et al., 2022; Prastya et al., 2023). However, many still report limited understanding of physiological indicators and scoring methods, which undermines the system's potential effectiveness (Braun et al., 2022; Sujalmo et al., 2022).

Finally, organizational culture and hierarchy exert significant influence. Concerns about physician response, fear of making mistakes, and overall workplace pressures can discourage staff from escalating care even when clinical indicators suggest it is warranted. This is particularly pronounced in hierarchical environments, where junior staff may feel unsupported or apprehensive about challenging authority (Flenady et al., 2020; Mikhail & King, 2025).

Organizational Factors

The presence of clear policies and standardized procedures is critical to achieving reliable documentation and escalation within EWS. Gawronski et al. found that while EWS scores were correctly calculated in 84% of cases, only half of the patients with high scores received timely clinical review (Gawronski et al., 2021). This finding suggests that technological systems, without the reinforcement of well-implemented standard operating procedures (SOPs) and consistent supervision, are insufficient to ensure patient safety.

Organizational mapping of barriers and enablers is vital, particularly in resource-limited settings. Agulnik demonstrated that the successful introduction of Paediatric Early Warning Systems (PEWS) in Latin American pediatric oncology hospitals was facilitated by managerial commitment, structured training, and integration with existing systems such as electronic medical records (EMRs) (Agulnik et al., 2023). Similarly, McKay et al., through the INSPIRE project, highlighted that sustained EWS use requires strong organizational infrastructure, encompassing robust training mechanisms, continuous feedback loops, and a culture of safety (McKay et al., 2023).

By contrast, in psychiatric facilities, documentation quality is often hindered by excessive workloads, inadequate staff orientation, and insufficient training (Prastya et al., 2023). To address these challenges, behavior-oriented strategies that engage staff participation and provide appropriate incentives have been recommended (McElroy et al., 2019; Swami et al., 2023; Woo et al., 2023). Furthermore, interprofessional collaboration and proactive leadership particularly in emergency and teaching hospital settings are recognized as crucial elements for ensuring successful EWS

implementation.

Intervention-Related Factors

The design and usability of EWS are critical determinants of their acceptance, consistent use, and overall effectiveness in clinical practice. When a system is overly complex, rigid, or not intuitive, healthcare staff may resist its use, resulting in poor adherence to protocols. Blythe et al. highlighted that successful EWS implementation is closely linked to system designs that complement clinical reasoning. Systems functioning merely as alarm triggers, without contextual flexibility, may erode user confidence and delay appropriate responses to patient deterioration (Blythe et al., 2024).

In a theory-driven intervention study, Smith et al. emphasized that the effectiveness of EWS is not solely dependent on the technology itself, but on how well it integrates into the behaviors and routines of healthcare workers. Using the Theoretical Domains Framework (TDF) and Behaviour Change Techniques (BCT), they identified barriers influencing nurses' responses and developed targeted training interventions to enhance compliance and clinical decision-making. (Smith et al., 2019) Similar improvements were observed in the study by Lourenco et al., where "just-in-time" NEWS2 training delivered during or immediately before clinical shifts significantly enhanced nurses' ability to detect patient deterioration and apply guidelines effectively. Unlike conventional theoretical training, this concise and context-based approach was perceived as more relevant and directly applicable to daily practice (Lourenço et al., 2023).

Integration of EWS into electronic health records (EHRs) has also been shown to improve accuracy and frequency in vital sign documentation. Mills et al. reported that embedding EWS into EMRs in Palestine resulted in documentation accuracy rates of nearly 90% (Mills et al., 2021). Carter et al. further demonstrated that electronic platforms such as DETECT e-PEWS were generally more positively received by nurses than physicians due to their ease of use, though some staff reverted to manual recording when the system felt unintuitive. Importantly, providing feedback grounded in patient outcome data enhanced compliance by making the clinical benefits of EWS more visible (Carter, Saron, Siner, et al., 2022).

Educational and adaptive training approaches have proven effective in building individual competencies. Studies by Graverholt and Hamada et al. showed that improved monitoring of vital signs particularly respiratory rate served as a tangible indicator of behavioral change aligned with patient safety practices (Graverholt et al., 2024; Hamada et al., 2025). However, evidence also suggests that system design and training alone are insufficient. Bedoya et al. found that even with NEWS integration into the EHR, utilization remained low in the absence of ongoing training and staff ownership, limiting its impact on key outcomes such as timely intervention and mortality reduction (Bedoya et al., 2019).

Environmental Factors

The effectiveness of EWS implementation is strongly shaped by the context in which it is applied. In resource-constrained settings, success depends less on technological sophistication and more on adaptability to local needs. Evidence from Brazil and Ethiopia shows that even with limited equipment and staffing, EWS can function effectively when systems are tailored to the local context, supported by adequate training, and implemented through flexible protocols (Moore et al., 2019; van der Fluit et al., 2021).

Agulnik and Woo et al. further noted that barriers such as staff resistance, shortages of essential equipment, and patient-related complexities frequently hinder EWS use in under-resourced hospitals (Agulnik, Schmidt-Grimminger, et al., 2022; Woo et al., 2023). These findings highlight the necessity of localized strategies that align with the realities of each healthcare environment .

Beyond hospital settings, the transferability of EWS to primary or community care introduces additional challenges. Brangan et al. observed that tools designed for acute hospital environments do not always translate well into community contexts, where patients present with different clinical profiles, monitoring opportunities are limited, and referral pathways are less structured (Brangan et al., 2018). Without careful adaptation, this misalignment may lead to both false alarms and missed detections, ultimately reducing system reliability.

CONCLUSION

This systematic review demonstrates that the implementation of EWS is influenced by a complex interaction of individual, organizational, intervention-related, and environmental factors. Successful implementation extends beyond the availability of technology or technical training alone and is closely associated with healthcare staff readiness, managerial commitment, and alignment with established workflows and organizational culture. The findings indicate variability in how these factors operate across different hospital contexts. Nevertheless, this review is limited by heterogeneity among EWS models, including NEWS, PEWS, and MEOWS, the potential exclusion of high-quality studies that were not open access, and the limited availability of quantitative evidence directly linking specific implementation factors to measurable clinical outcomes.

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